Bibliometric Analysis of the
NCI Physical Sciences – Oncology Centers Program Outputs

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PHYSICAL SCIENCES in ONCOLOGY

Abstract

In fiscal year (FY) 2009, the NCI Office of Physical Sciences - Oncology initiated the **Physical Sciences-Oncology Centers (PS-OC) Program** consisting of a network of 12 centers with the goal of converging physical sciences with existing disciplines in cancer research by building cross-disciplinary teams and infrastructure. In the first 4.5 years of the program, a process evaluation of the PS-OC Program was initiated and performed to assess program performance and to promote positive adjustments of the current program and future phases. This evaluation included the collection and analysis of publication information via progress reports provided by each center and additional databases. Publication sets of key PS-OC investigators (PIs, SIs, and Project leaders) were derived from 2004 to December 2013, using name matching algorithms augmented by author metadata (e.g., email address). These publication sets were used to analyze metrics before and after the PS-OC Program in order to compare the impact of the Program on investigator scientific output. Several metrics were analyzed for publication sets prior to and during funding of the PS-OC Program, such as Field Convergence, Journal Impact Factor, Citations, Citation Benchmark Ratios, and Bibliometric Percentiles. The following results pertain to bibliometric analysis for the first 4.5 years of the Program.

NCI Physical Sciences – Oncology Centers Program

Physical Sciences – Oncology Centers (PS-OCs):

➤ Twelve Centers were funded by NCI in September 2009 through U54 mechanism
➤ Each Center is composed of physical scientists and cancer biologists and consists of 3-5 Projects and at least 2 collaborative Cores.
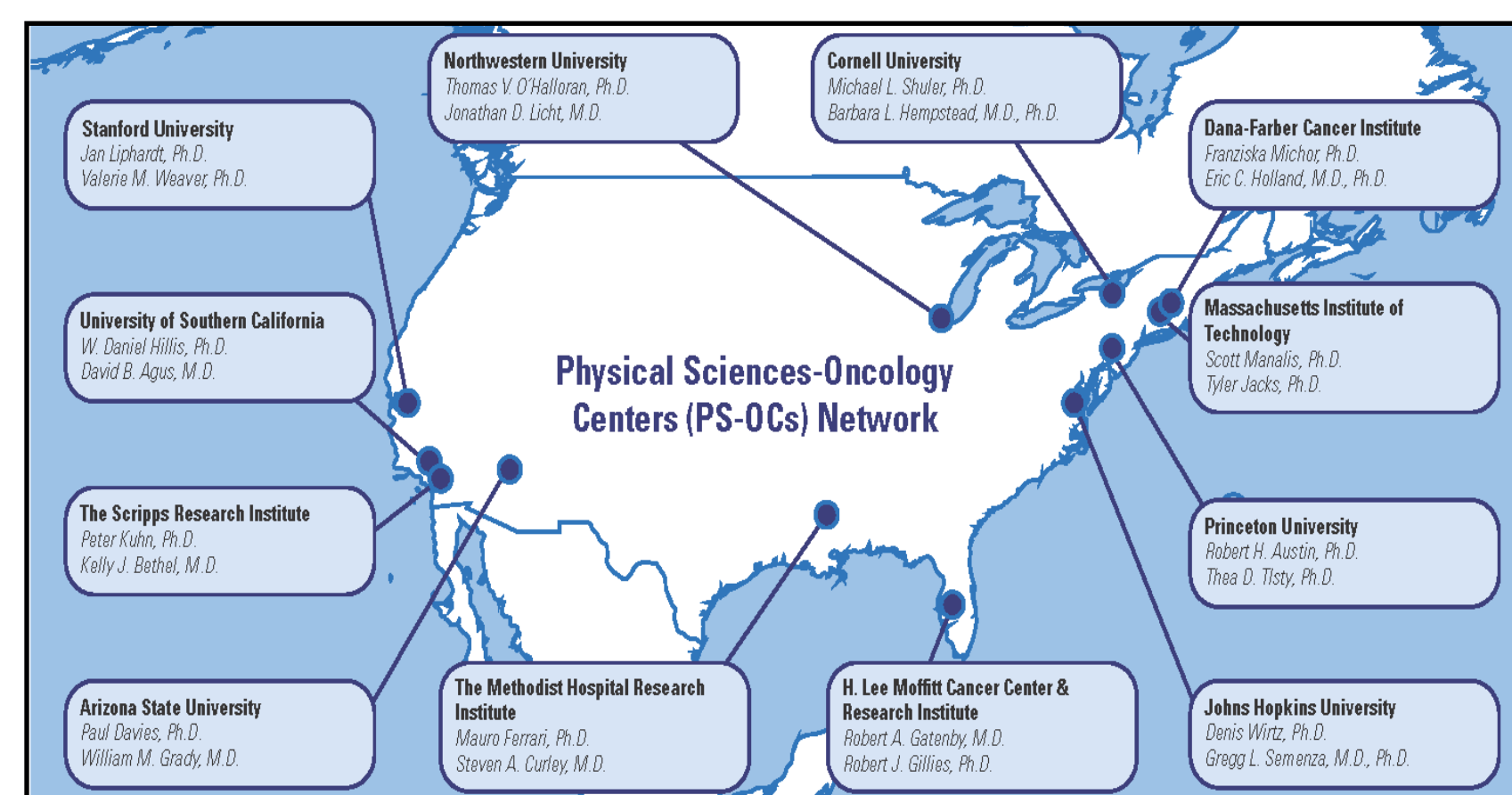
Figure 1. Location and leadership scheme of the twelve Physical Sciences – Oncology Centers (PS-OCs) funded by NCI. Each PS-OC has a principal investigator (PI) that is a physical scientist and a senior investigator (SI) that is a cancer biologist. Each PS-OC averages 10-12 investigators. The PS-OCs are located at Arizona State University (ASU), Cornell University, Dana-Farber Cancer Institute (DFCI), H. Lee Moffitt Cancer Center, Johns Hopkins University (JHU), Massachusetts Institute of Technology (MIT), Northwestern University, Princeton University, The Methodist Hospital Research Institute (TMHRI), Stanford University, and University of Southern California (USC).

Program Objectives:

➤ Generate *new knowledge* and catalyze *new fields of study* in cancer research by utilizing physical sciences/engineering principles
➤ Enable a better understanding of cancer and its behavior at **ALL** scales
➤ Develop new perspectives and approaches to do *paradigm-shifting* science
➤ Build *cross-disciplinary teams* and infrastructure to better understand and control cancer through the convergence of physical sciences and cancer biology
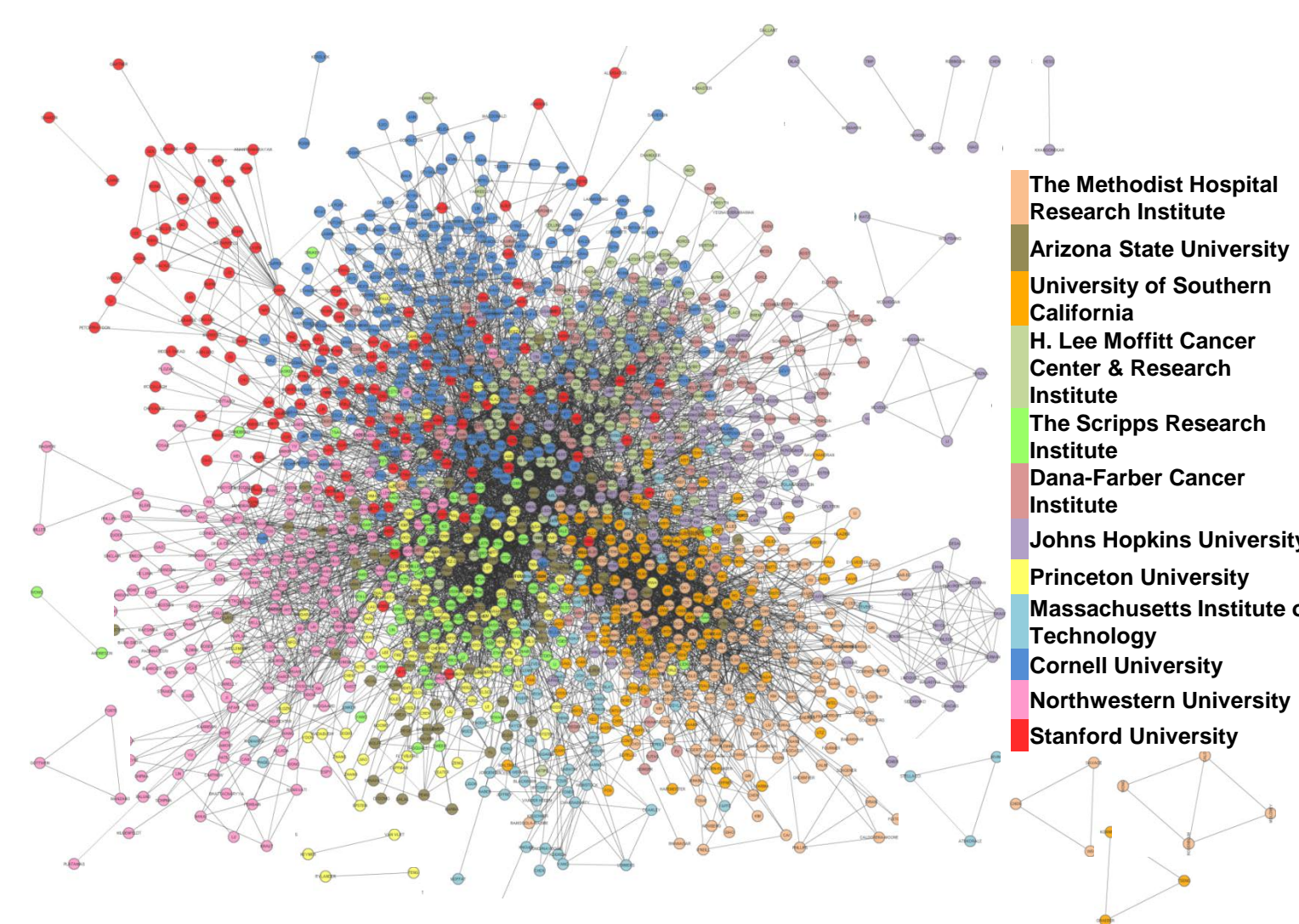
Figure 2. The PS-OC Program Network. Diagram depicting the collaborative nature of the PS-OC Network. Individual investigators are represented by colored dots and each color represents a different PS-OC. Lines between dots represent investigator collaborations reported in the progress reports as well as pairwise authorship collaborations. Note that collaborations occur both within a given Center as well as across the Network. For more information on the analysis of PS-OC Network collaborations, please see poster C-13.

The Methodist Hospital Research Institute
Arizona State University
University of Southern California
H. Lee Moffitt Cancer Center & Research Institute
The Scripps Research Institute
Dana-Farber Cancer Institute
Johns Hopkins University
Princeton University
Massachusetts Institute of Technology
Cornell University
Northwestern University
Stanford University

METHODS

Data sources:

➤ Bi-annual, self-reported PS-OC progress reports
➤ Pre-award publications of the 235 PS-OC investigators from 2004 – 2008

Data analysis resources:

➤ Interdisciplinary Team Reporting, Analysis, and Query Resource (**iTRAQR**) system
➤ Thomson Reuters Web of Science database
➤ Thomson Reuters ScienceWire database
➤ NIH Scientific Publication Information Retrieval & Evaluation System (SPIRES)
➤ NIH Query, View and Report (QVR)

RESULTS

➤ **Productivity.** Over the first 4.5 years of the Program, the PS-OC Network produced almost 1200 reported publications in almost 400 different journals, many of them high-impact in nature.
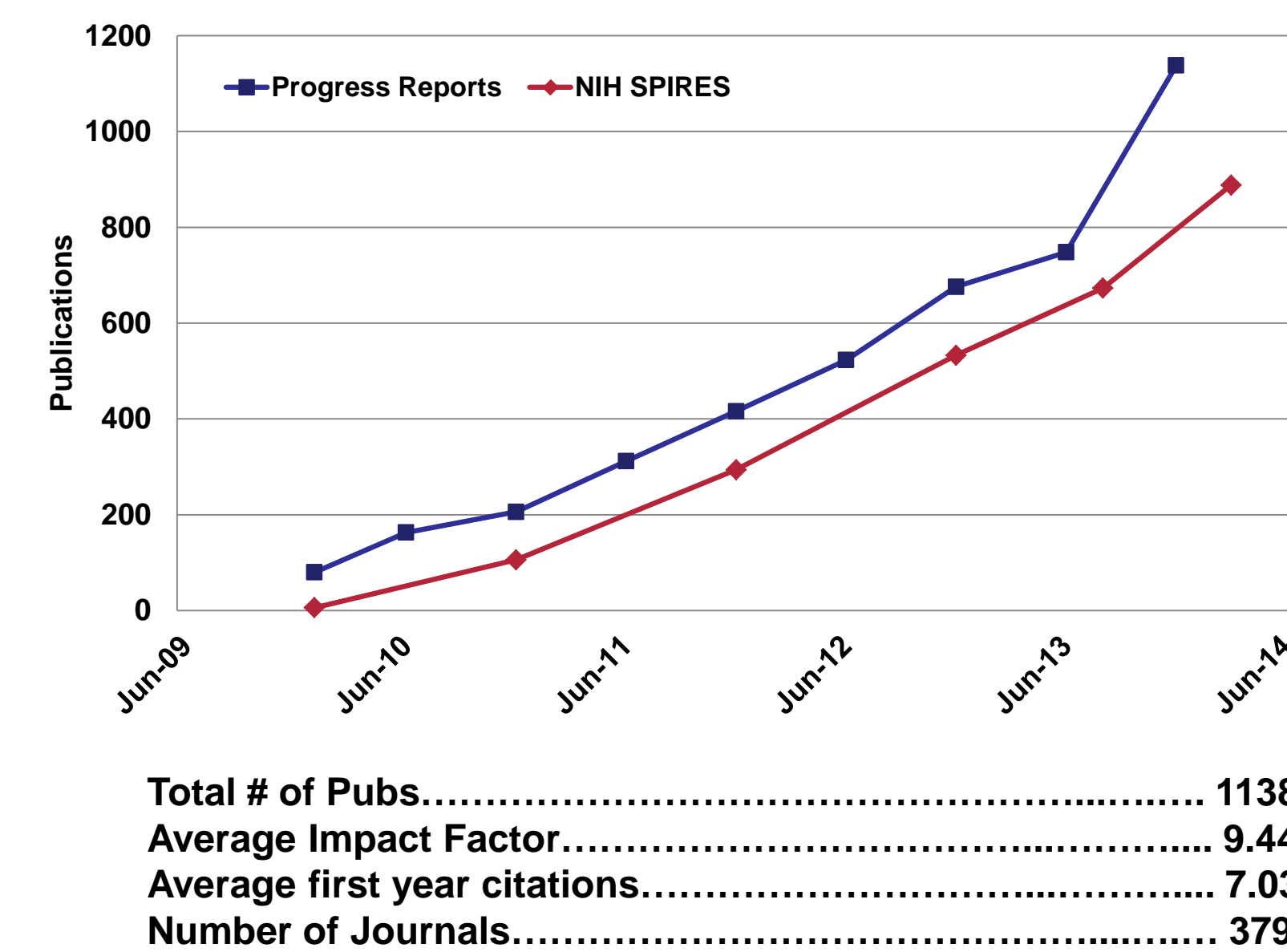
MOST FREQUENT JOURNALS		
Journal	No. Pubs	Impact Factor
PLoS One	59	4.14
PNAS	57	9.48
Cancer Research	36	7.93
Physical Biology	30	2.59
Cell	20	32.2
Blood	19	9.62
Nature	19	36.2
Biophysical Journal	18	3.78
Nucleic Acids Research	17	7.64
Biomaterials	14	7.50
Lab on a Chip	14	5.31
Nature Biotechnology	14	26.1

Total # of Pubs... 1138
Average Impact Factor....................................... 9.44
Average first year citations............................... 7.03
Number of Journals.. 379

Figure 3. PS-OC Network publication productivity September 2009 – April 2014. Cumulative publication numbers across the PS-OC Network. Reported publication numbers from the progress reports were compared with publications found in the NIH SPIRES, a database listing publications according to author-reported NIH grant numbers.

Table 1. Most frequent journals. Top 12 journals in which PS-OC Network publications were most frequently published. Table includes total numbers of publications for each journal and corresponding journal impact factor.

➤ **Field convergence.** PS-OC Network investigators produced an increased number of publications that were cross-disciplinary in nature in comparison with those produced before the start of the PS-OC Program.
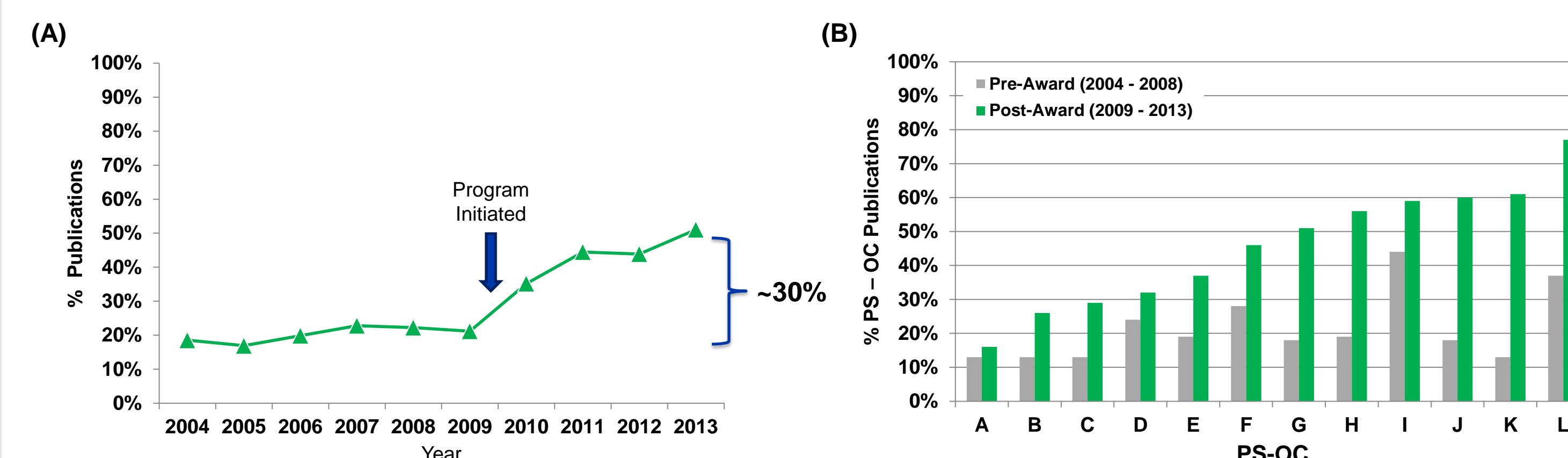
Figure 4. Cross-disciplinary publication content pre- and post-award. Sets of physical sciences (PS) and oncology (OC) terms were extracted from 100,000 randomly selected publications in the PS and OC subject categories using the Thomson Reuters Web of Science database. Titles and abstracts of publications from Network investigators were then mined for PS and/or OC terms. Publications were considered to be cross-disciplinary if they contained both PS and OC terms. (A) Cumulative increases in percentage of cross-disciplinary publications being produced across the PS-OC Network. Since the program's initiation in September 2009, there has been an approximately 30% increase in cross-disciplinary publications. (B) Cross-disciplinary publication content by individual PS-OC (randomly assigned a letter, A – L), pre- vs. post-award.
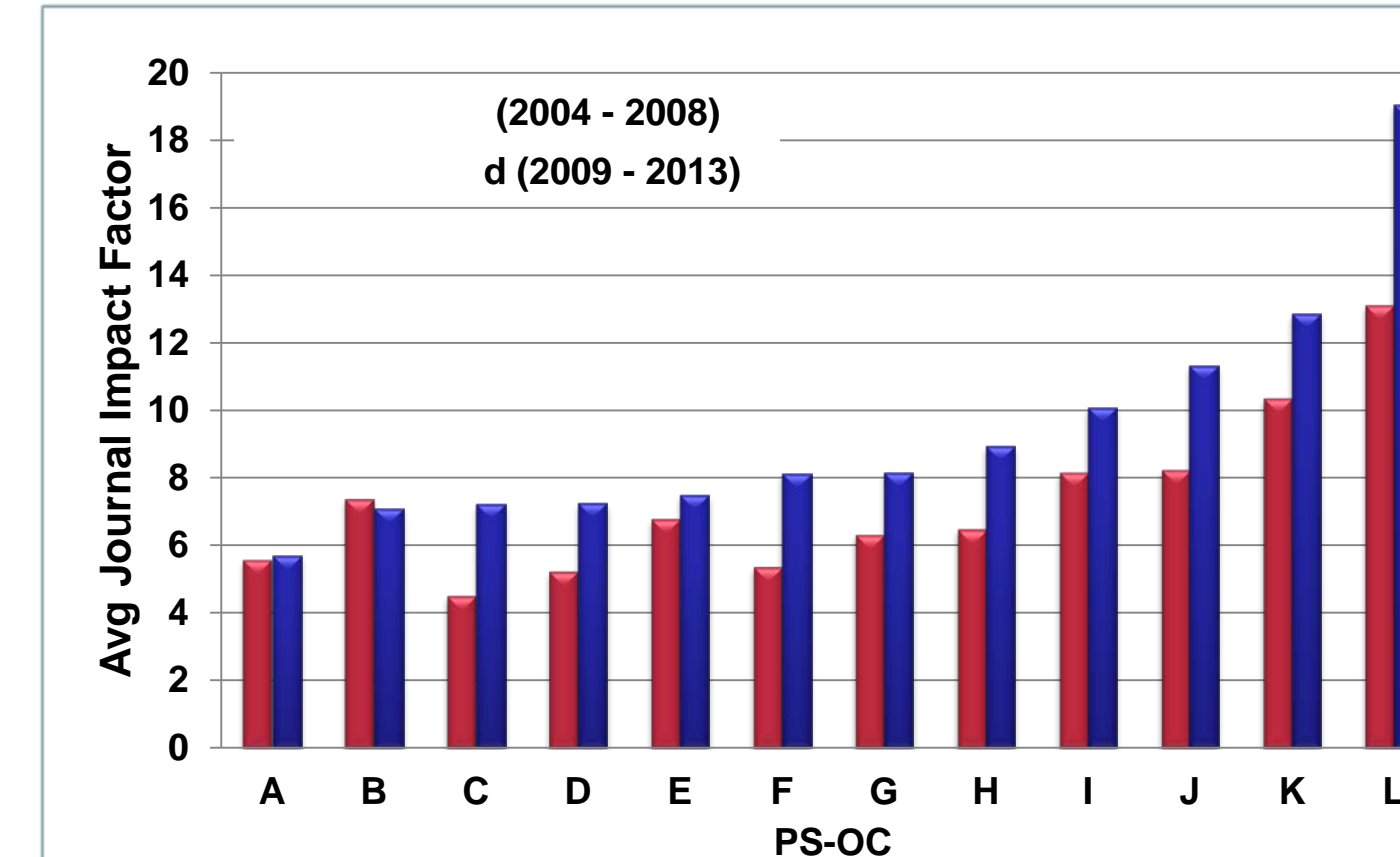
Figure 5. Average journal Impact factors for individual PS-OCs pre- and post-award. Journal impact factors (average number of citations per paper in a given journal over a 2-year period) for reported Network publications were obtained from Web of Science. Average impact factor numbers were then calculated for cumulative publications from each PS-OC (randomly assigned A – L). For comparison purposes, average impact factors for pre-award publications (2004 – 2008) from PS-OC investigators were also calculated using metadata from the Thomson Reuters ScienceWire database.
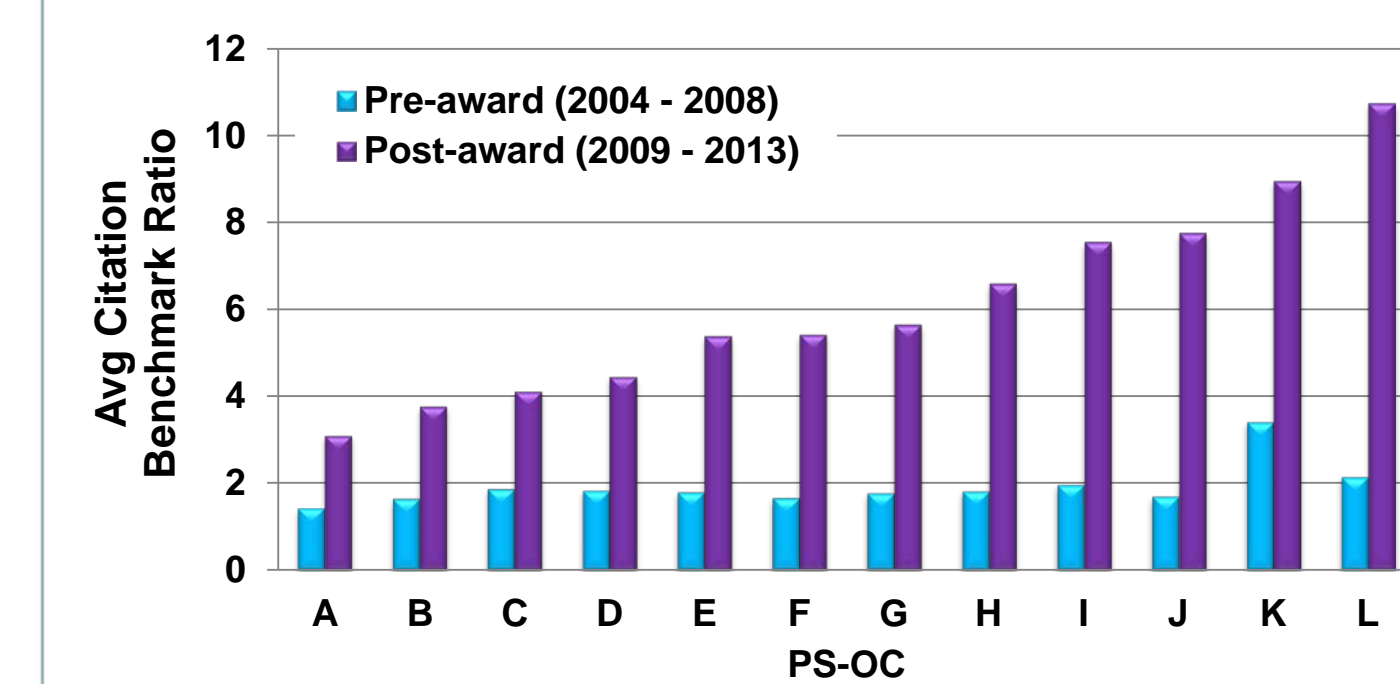
Figure 6. Average one-year citations for individual PS-OCs pre- and post-award. Using Web of Science, numbers of citations accumulated within one year of publication were determined for each PS-OC Network publication. Average one-year citation numbers for publications from each PS-OC were then calculated.

Figure 7. Average citation benchmark ratios for individual PS-OCs pre- and post-award. A citation benchmark ratio indicates the ratio by which a publication within a given subject field is cited within the first year of publication in comparison with the average number of citations for that year in the same field. Using Web of Science, average citation benchmark ratios for cumulative publications from each PS-OC were calculated and compared to pre-award citation benchmark ratios.

AVG. BIBLIOMETRIC PERCENTILES		
Center	Pre-Award	Post-Award
A	61%	67%
B	64%	69%
C	66%	70%
D	65%	73%
E	66%	74%
F	72%	74%
G	65%	75%
H	69%	76%
I	69%	77%
J	68%	78%
K	77%	80%
L	64%	85%

Table 2. Average bibliometric percentiles for individual PS-OCs pre- and post-award. A bibliometric percentile indicates how well a given publication performs (i.e., accumulates citations) compared to other publications from the same year and subject field. The percentile is determined by creating a distribution frequency of one-year citation numbers for all of the papers from a given field and year. Using Web of Science, bibliometric percentiles for cumulative publications from each PS-OC were calculated and compared to pre-award bibliometric percentiles.

➤ **Impact.** During the course of the Program, average journal impact factors, one-year citation numbers, citation benchmark ratios, and bibliometric percentiles of publications produced by the Network increased in a majority of PS-OCs compared to publications accumulated in the 5 years prior to the grant award.

➤ **Comparison to other funding mechanisms.** PS-OC Network Projects produced more publications in comparison to R01-supported projects of similar research scope.

Figure 8. Publication outputs of PS-OC Subprojects and R01-funded Research Projects of similar theme. Cumulative publication numbers from 41 PS-OC Subprojects, as well as from two independent groups of R01-funded Research Projects (41 Projects per group), were determined over a 4-year period. Research projects similar in scope to the PS-OC Subprojects were identified using the NIH QVR database system.
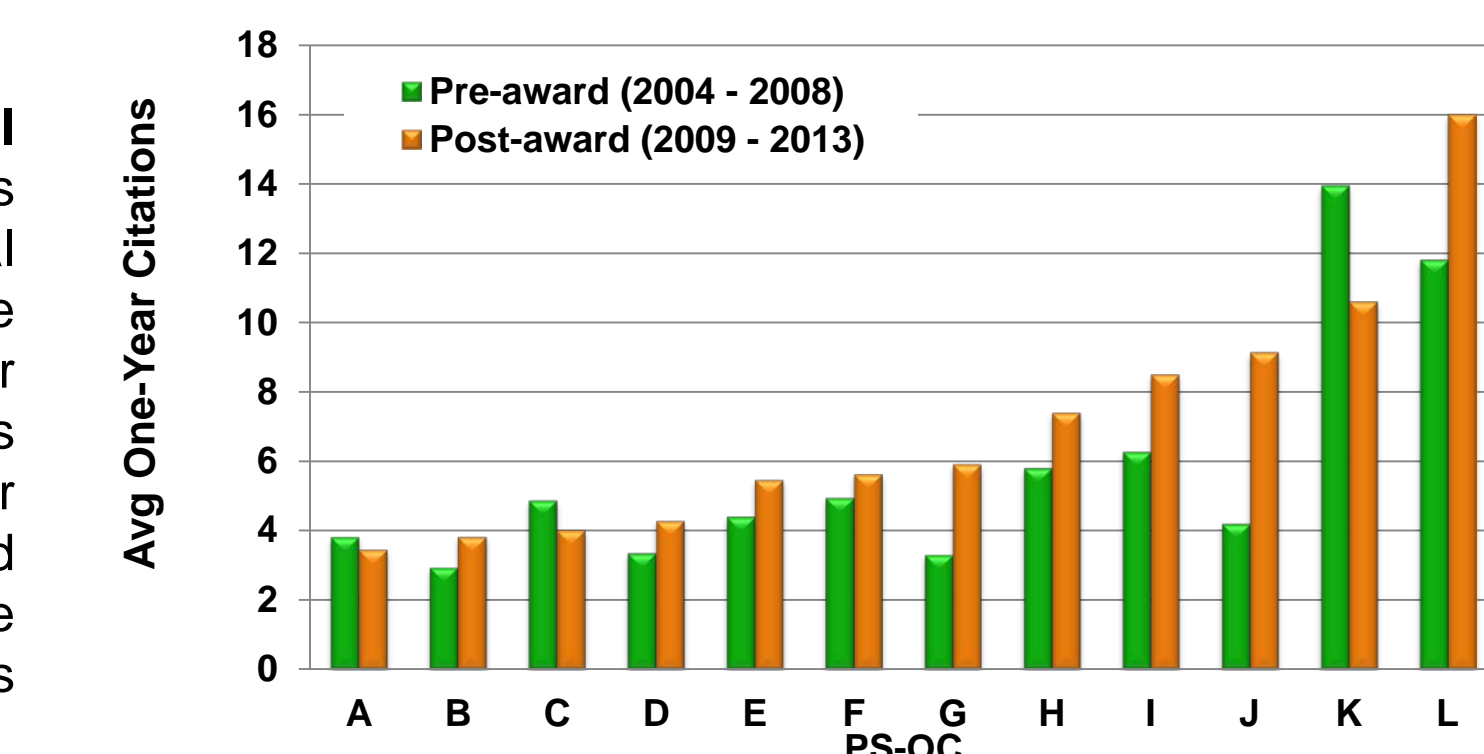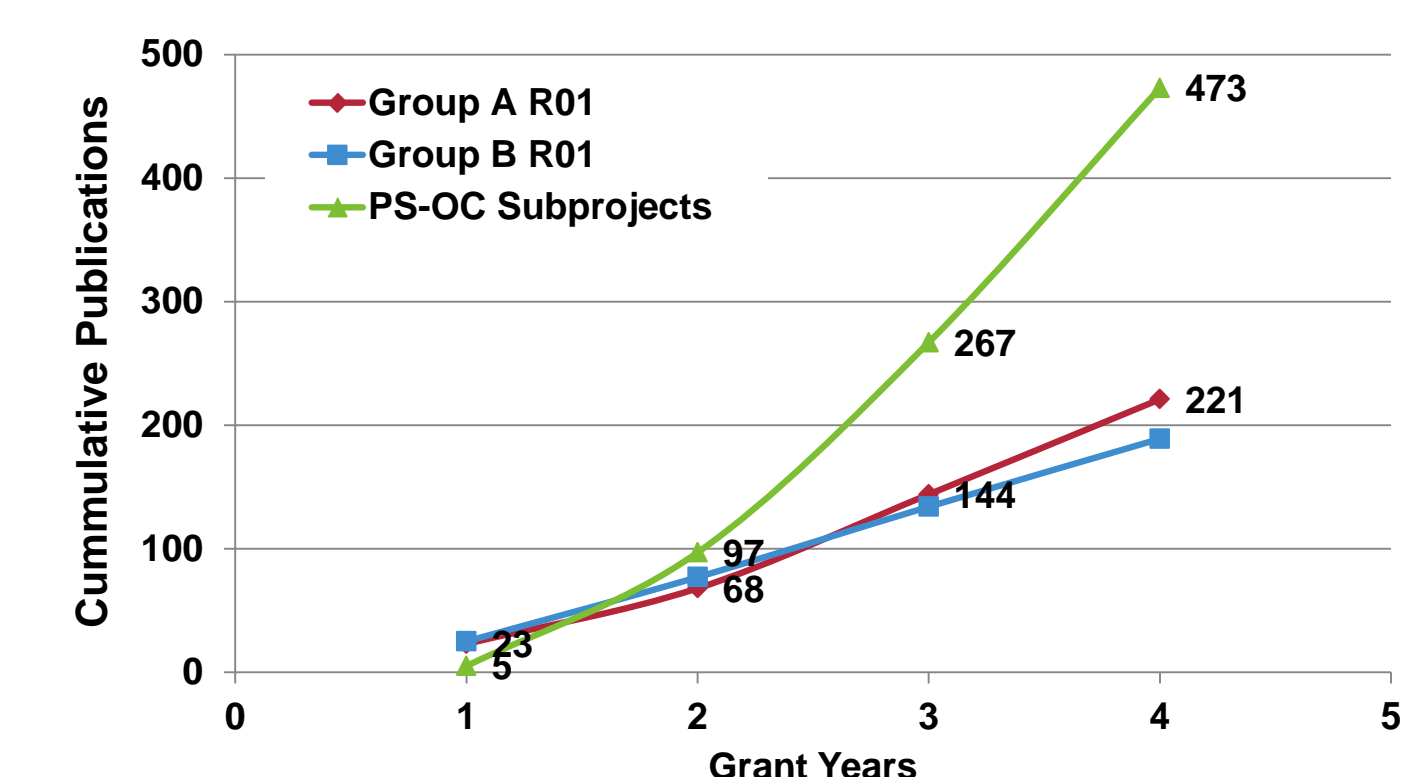
CONCLUSIONS

➤ Since the PS-OC Program's initiation, the PS-OC Network has produced publications high in both quantity and quality.

➤ PS-OC investigators have published at an accelerated rate in comparison with traditional R01-funded Projects of similar scope after two years of the program's implementation.

➤ PS-OC Network publications are, on average, increasingly cross-disciplinary in nature.

➤ Publications emerging from PS-OC Network investigators are more impactful in terms of (1) publication in higher-impact journals, (2) increased citation numbers in comparison with pre-award years, and (3) increased citation numbers compared to publications from the same subject field and year.